U.S. Express Mail Label No. EL857532136US
System And Methods For Invalidation To Enable
Caching Of Dynamically Generated Content
Inventors: Wen-Syan Li et al.
Attorney: Ronald Coslick – 073303-0118
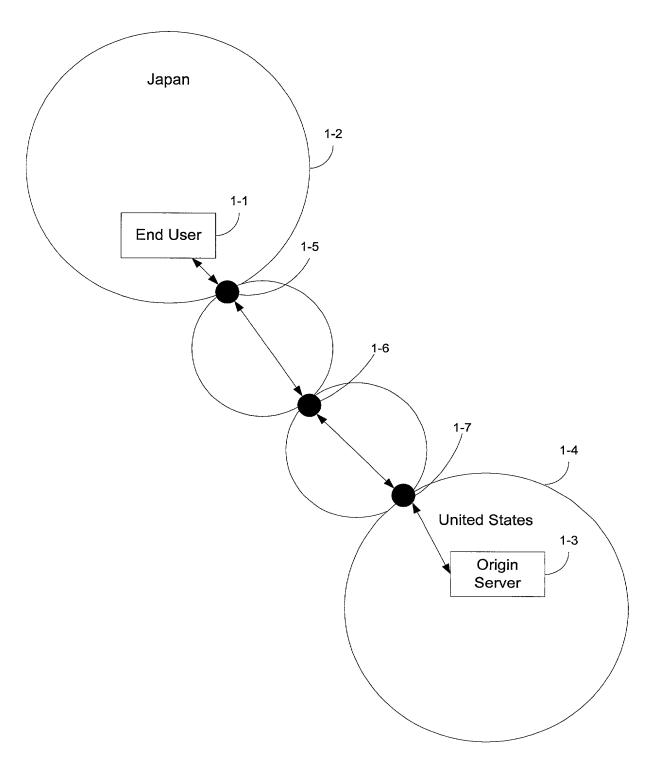FOLEY & LARDNER – (310) 277-2223
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Figure 1

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# Figure 2

**Content Generation**

Database Mangement System — 2-2

Data Cache

Application Server — 2-4

**Content Delivery**

Web Server — 2-6

Front End Cache

Internet

User

User

User

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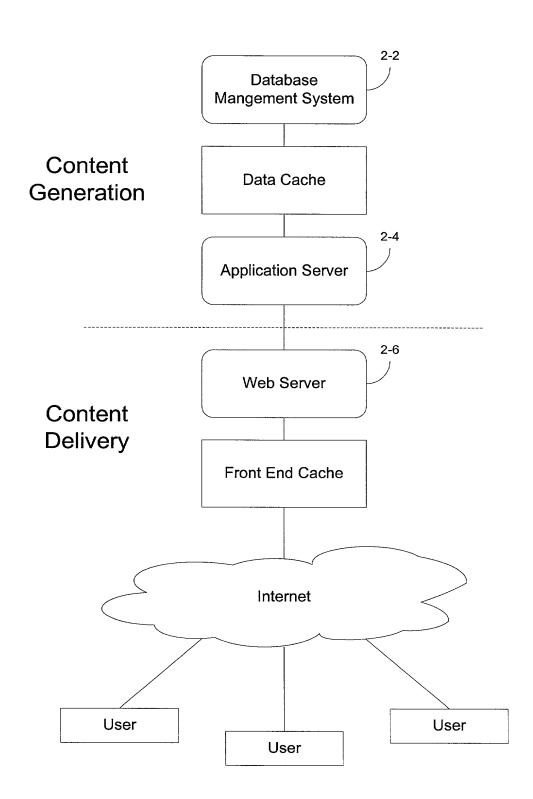FOLEY & LARDNER – (310) 277-2223
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# Figure 3

Data ⟷ Queries ⟷ Content

# Figure 4

```
┌─────────────────────┐  4-2
│  Determine database │
│       changes       │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐  4-4
│  Determine queries to│
│  be invalidated from │
│  the database changes│
└─────────────────────┘
           │
           ▼
┌─────────────────────┐  4-6
│  Determine cached   │
│  content related to the│
│       queries       │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐  4-8
│  Send invalidation  │
│  messages to caches │
│  or web servers that │
│  contain the content │
└─────────────────────┘
```

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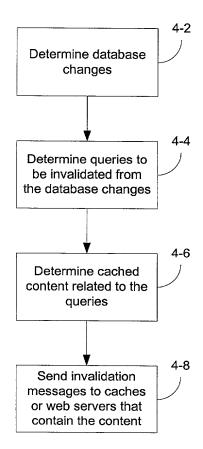Inventors: Wen-Syan Li et al.
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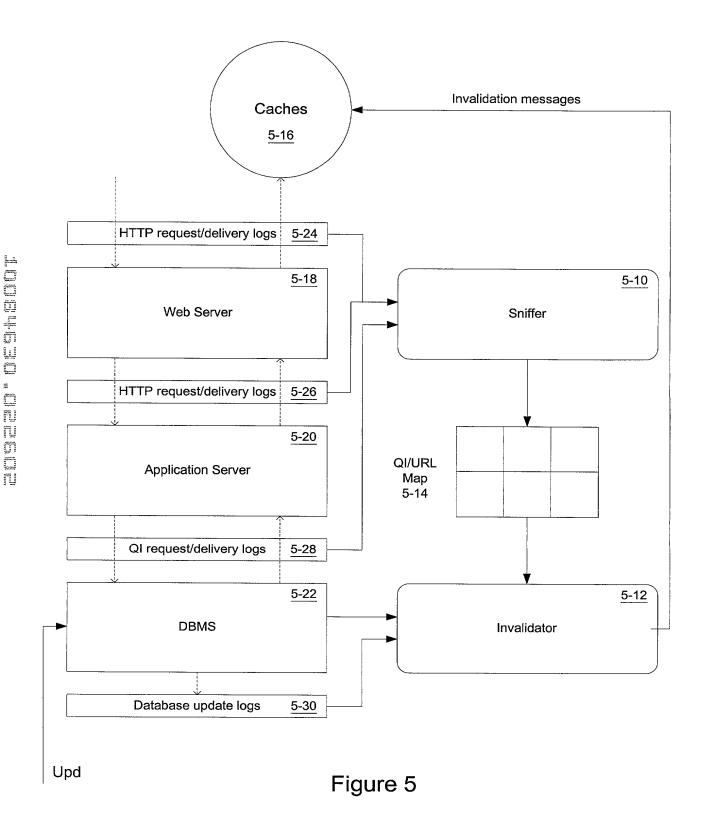FOLEY & LARDNER – (310) 277-2223
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Invalidation messages

Caches

5-16

HTTP request/delivery logs    5-24

Web Server    5-18

Sniffer    5-10

HTTP request/delivery logs    5-26

Application Server    5-20

QI/URL
Map
5-14

QI request/delivery logs    5-28

DBMS    5-22

Invalidator    5-12

Database update logs    5-30

Upd

Figure 5

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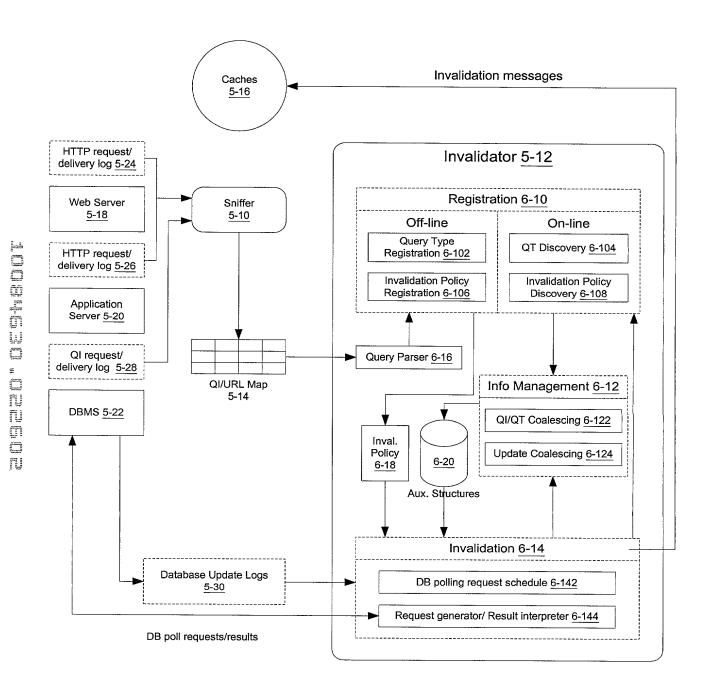FOLEY & LARDNER – (310) 277-2223
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Invalidation messages

Caches
5-16

HTTP request/
delivery log 5-24

Web Server
5-18

Sniffer
5-10

HTTP request/
delivery log 5-26

Application
Server 5-20

QI request/
delivery log 5-28

QI/URL Map
5-14

Query Parser 6-16

DBMS 5-22

Inval.
Policy
6-18

6-20

Aux. Structures

Database Update Logs
5-30

DB poll requests/results

**Invalidator 5-12**

**Registration 6-10**

Off-line

Query Type
Registration 6-102

Invalidation Policy
Registration 6-106

On-line

QT Discovery 6-104

Invalidation Policy
Discovery 6-108

**Info Management 6-12**

QI/QT Coalescing 6-122

Update Coalescing 6-124

**Invalidation 6-14**

DB polling request schedule 6-142

Request generator/ Result interpreter 6-144

# Figure 6

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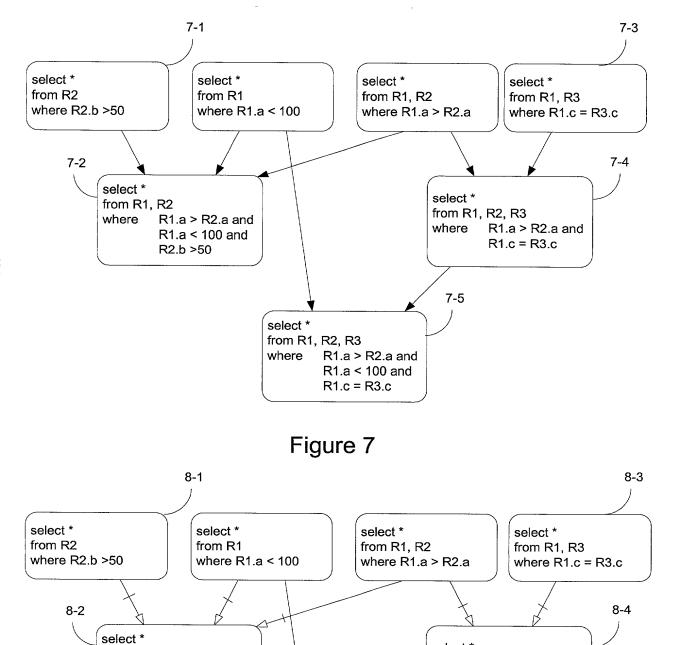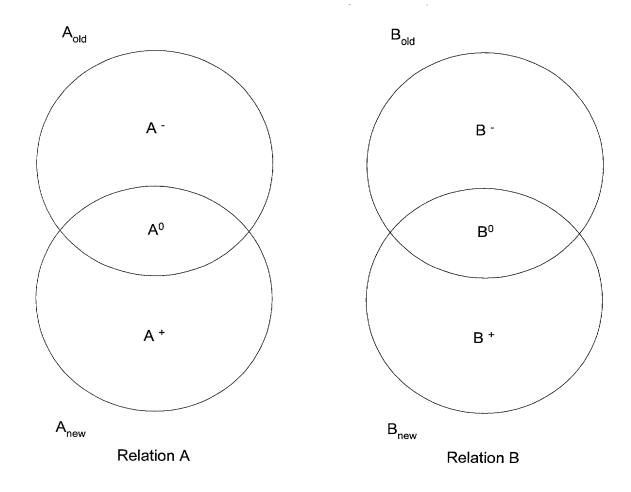FOLEY & LARDNER – (310) 277-2223
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**7-1**

select *
from R2
where R2.b >50

select *
from R1
where R1.a < 100

select *
from R1, R2
where R1.a > R2.a

**7-3**

select *
from R1, R3
where R1.c = R3.c

**7-2**

select *
from R1, R2
where     R1.a > R2.a and
          R1.a < 100 and
          R2.b >50

**7-4**

select *
from R1, R2, R3
where     R1.a > R2.a and
          R1.c = R3.c

**7-5**

select *
from R1, R2, R3
where     R1.a > R2.a and
          R1.a < 100 and
          R1.c = R3.c

## Figure 7

**8-1**

select *
from R2
where R2.b >50

select *
from R1
where R1.a < 100

select *
from R1, R2
where R1.a > R2.a

**8-3**

select *
from R1, R3
where R1.c = R3.c

**8-2**

select *
from R1, R2
where     R1.a > R2.a or
          R1.a < 100 or
          R2.b >50

**8-4**

select *
from R1, R2, R3
where     R1.a > R2.a or
          R1.c = R3.c

**8-5**

select *
from R1, R2, R3
where     R1.a > R2.a or
          R1.a < 100 or
          R1.c = R3.c

## Figure 8

$A_{old}$

$A^-$

$A^0$

$A^+$

$A_{new}$

Relation A
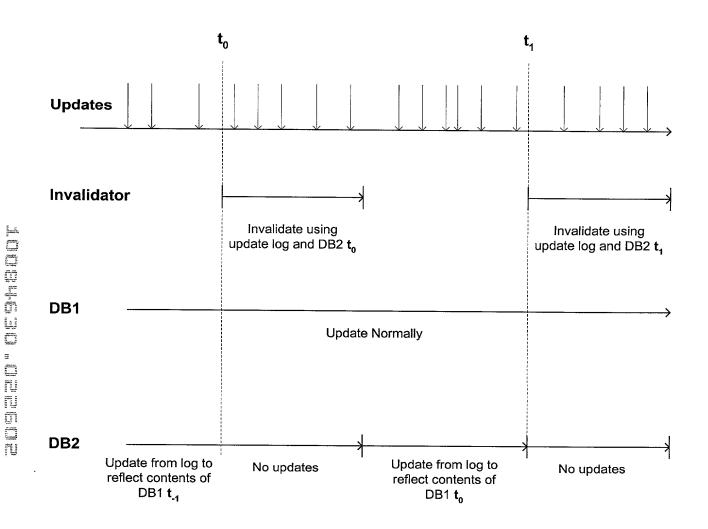
$B_{old}$

$B^-$

$B^0$

$B^+$

$B_{new}$

Relation B

# Figure 9

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**Updates**

**Invalidator**

Invalidate using
update log and DB2 $t_0$

Invalidate using
update log and DB2 $t_1$

**DB1**

Update Normally

**DB2**

Update from log to
reflect contents of
DB1 $t_{-1}$

No updates

Update from log to
reflect contents of
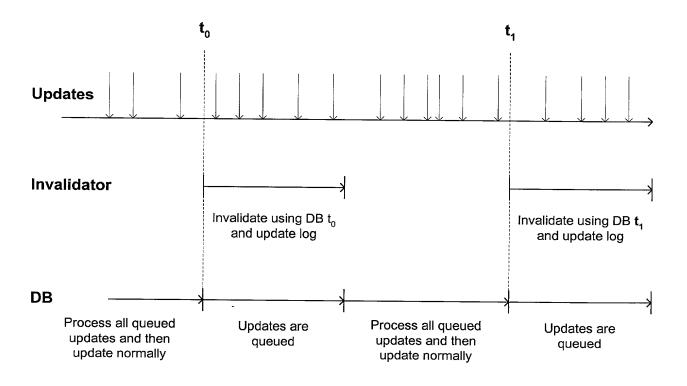DB1 $t_0$

No updates

$t_0$        $t_1$

## Figure 10

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$t_0$        $t_1$

**Updates**

**Invalidator**

Invalidate using DB $t_0$
and update log

Invalidate using DB $t_1$
and update log

**DB**

Process all queued
updates and then
update normally

Updates are
queued

Process all queued
updates and then
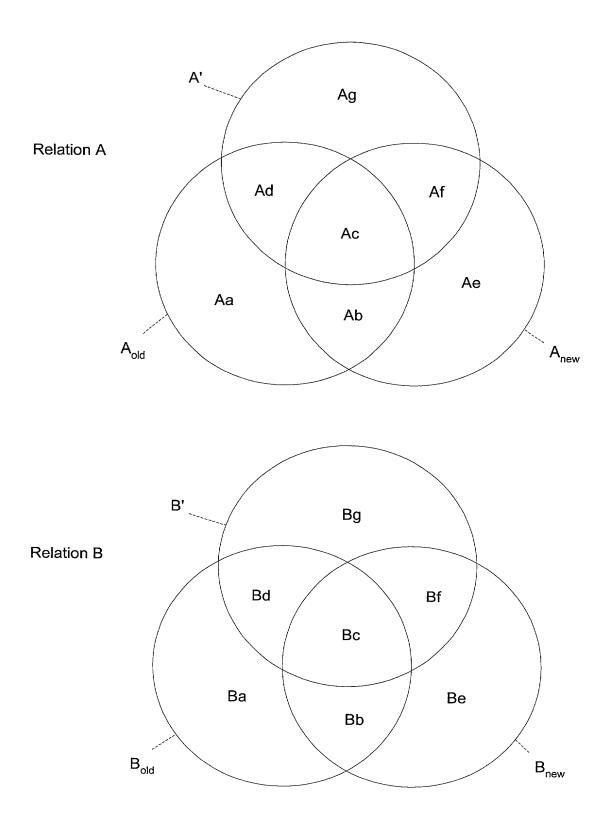update normally

Updates are
queued

# Figure 11

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Relation A

Relation B

Figure 12

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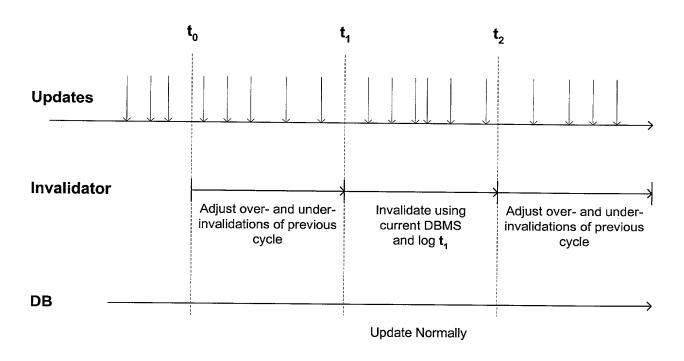FOLEY & LARDNER – (310) 277-2223
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Figure 13